# 2nd International Conference on Cat-CVD (Hot-Wire CVD) Process

# TECHNICAL PROGRAM

## TUESDAY MORNING - SEPTEMBER 10

**OPENING PLENARY SESSION**
**(9:40 a.m. – 12:15 a.m., Tuesday)**

| | | |
|---|---|---|
| 9:40 a.m. | Welcome to 2nd International Conference on Cat-CVD (Hot-Wire CVD) Process | Harv Mahan and Larry Kazmerski<br>NREL |
| 10:00 a.m. | Silicon for thin-film transistors | Sigurd Wagner<br>Princeton University |
| 10:30 a.m. | Status report: Solar cell related research and development using a-Si:H and µc-Si deposited by HW(CAT)CVD | Bernd Schröder<br>University of Kaiserslautern |
| ***11:00 to 11:15 a.m.*** | - ***Coffee Break*** - | |
| 11:15 a.m. | Some Perspectives on Hot-Wire CVD Learned From Growing Diamond Thin Films | Philip Morrison<br>Case Western Reserve University |
| 11:45 a.m. | Recent Progress of Cat-CVD Research in Japan: Bridging the 1st and 2nd Cat-CVD Conferences | Hideki Matsumura<br>JAIST |

## TUESDAY AFTERNOON - SEPTEMBER 10

**FUNDAMENTALS – I**
**(2:00 p.m. – 3:30 p.m., Tuesday)**
**Session Chairman – Vik Dalal (Iowa State University)**

| | | | | |
|---|---|---|---|---|
| 2:00 p.m. | (TuA1) | Invited | Elementary Reactions in Silicon CAT-CVD Process | Mitsuo Koshi<br>Tokyo University |
| 2:30 p.m. | (TuA2) | Oral | Early Time Evolution of Thin Film Silicon Growth by HWCVD | Dean H. Levi<br>NREL |
| 2:50 p.m. | (TuA3) | Oral | Measurements of Radicals at the Substrate Surface | Wengang Zheng<br>JILA/NIST/ University of Colorado |
| 3:10 p.m. | (TuA4) | Oral | Deposition Chemistry in the Cat-CVD Processes of the $SiH_4/NH_3$ System | Hironobu Umemoto<br>JAIST |
| ***3:30 to 4:00 p.m.*** | | | - ***Coffee Break*** - | |

**FILM PROPERTIES – I**
**(4:00 p.m. – 5:30 p.m., Tuesday)**
**Session Chairman – Harry Atwater (Cal Tech University)**

| | | | | |
|---|---|---|---|---|
| 4:00 p.m. | TuB1 | Invited | Combinatorial HWCVD Approach to Thin Film Si Materials and Devices | Qi Wang<br>NREL |
| 4:30 p.m. | TuB2 | Oral | the Silicon Neighborhood Across the a-Si:H to µc-Si Transition by X-Ray Absorption Spectroscopy | Leandro Tessler<br>IFGW-Unicamp |
| 4:50 p.m. | TuB3 | Oral | Catalytic CVD Growth of Si-C and Si-C-O Alloy Films by using Alkylsilane and Related Compounds | Hiroshi Nakayama<br>Osaka City University |
| 5:10 p.m. | TuB4 | Oral | Growth and Properties of a-Si:H Films Grown with Combined Cat CVD and ECR Plasma Techniques | Vikram Dalal<br>Iowa State University |

## WEDNESDAY MORNING - SEPTEMBER 11

**DEVICES – I**
**(8:30 a.m. – 10:00 a.m., Wednesday)**
**Session Chairman – Ruud Schropp (Utrecht University)**

| | | | | |
|---|---|---|---|---|
| 8:30 a.m. | WeA1 | Invited | Microcrystalline Silicon Prepared by Hot-Wire CVD for Thin Film Solar Cells | Stefan Klein<br>Forschungszentrum Juelich |
| 9:00 a.m. | WeA2 | Oral | Development of Hot-Wire CVD n-Type Emitter on p-Type Crystalline Si Based Solar Cells | Matt Page<br>NREL |
| 9:20 a.m. | WeA3 | Oral | Microcrystalline Silicon Solar Cells Deposited at High Deposition Rates by Hot-Wire CVD | Eugene Iwaniczko<br>NREL |
| 9:40 a.m. | WeA4 | Oral | Incorporation of Amorphous and Microcrystalline Silicon in N-I-P Solar Cells | Marieke K. van Veen<br>Utrecht University |
| ***10:00 to 10:30 a.m.*** | | | - ***Coffee Break*** - | |

**HIGH–GROWTH RATE AND INDUSTRIAL APPLICATIONS**
**(10:30 a.m. – 12:00 noon, Wednesday)**
**Session Chairman – Joao Conde (Inst. Superior Tech.)**

| | | | | |
|---|---|---|---|---|
| 10:30 a.m. | WeB1 | Invited | Development of Cat-CVD Apparatus for 1 m Size Large Area Deposition | Keiji Ishibashi<br>ANELVA Corp. |
| 11:00 a.m. | WeB2 | Oral | Project Study for the Hot-Wire Chemical Vapor Deposition of Amorphous Silicon Based Solar Cells Moving in Industrial Production | Bernd Schröder<br>University of Kaiserlautern |
| 11:20 a.m. | WeB3 | Oral | Highly Conducting p-Type Poly-Si Deposited by HWCVD and its Applicability As Gate Material for CMOS Devices | Samadhan Patil<br>Indian Institute of Technology |
| 11:40 p.m. | WeB4 | Oral | Deposition of HWCVD Poly-Si Films at a High Growth Rate | Jatindra K. Rath<br>Utrecht University |

## WEDNESDAY AFTERNOON - SEPTEMBER 11

**FILM PROPERTIES – II**
**(1:30 p.m. – 3:00 p.m., Wednesday)**
**Session Chairman – Hideki Matsumura (JAIST)**

| | | | | |
|---|---|---|---|---|
| 1:30 p.m. | WeC1 | Invited | Hydrogen Distribution, Nanostructures and Optical Properties of High Deposition Rate Hot-Wire CVD a-Si:H | Yue Wu<br>University of North Carolina |
| 2:00 p.m. | WeC2 | Oral | Electrical Properties of Cat-CVD $SiN_x$ Films Deposited on Catalytically Nitrided Si(100) | Akiko Kikkawa<br>JAIST |
| 2:20 p.m. | WeC3 | Oral | Narrow Gap a-SiGe:H Grown by HWCVD | Brent Nelson<br>NREL |
| 2:40 p.m. | WeC4 | Oral | Quantitative Analysis of Tungsten, Oxygen, and Carbon Concentrations in the Microcrystalline Silicon Films Grown by Hot-Wire CVD | Jean-Eric Bourée<br>École Polytechnique |
| **3:00 to 3:30 p.m.** | | | - ***Coffee Break*** - | |

**FILM PROPERTIES – II (continued)**

**(3:30 p.m. – 4:50 p.m., Wednesday)**

**Session Chairman – Markus Schubert (Stuttgart Univ.)**

| | | | | |
|---|---|---|---|---|
| 3:30 p.m. | WeC5 | Oral | Optoelectronic and Photovoltaic Properties of HW-CVD Deposited a-SiGe:H/μc-Si:H Multilayer Structures | Sandesh R. Jadkar<br>University of Pune |
| 3:50 p.m. | WeC6 | Oral | Characterization of Cat CVD Grown Si-C and Si-C-O Dielectric Films For ULSI Applications | Hiroshi Nakayama<br>Osaka City University |
| 4:10 p.m. | WeC7 | Oral | Deposition and Structural Characterization of Poly-Si Thin Films on Al Coated Glass Substrates | Ozgenc Ebil<br>University of Delaware |
| 4:30 p.m. | WeC8 | Oral | High Rate Deposition of a-Si:H Films using HWCVD with a Coil-Shaped Filament | Xunming Deng<br>University of Toledo |

## THURSDAY MORNING - SEPTEMBER 12

**FUNDAMENTALS – II**

**(8:30 a.m. – 10:00 a.m., Thursday)**

**Session Chairman – Arun Madan (MVSystems)**

| | | | | |
|---|---|---|---|---|
| 8:30 a.m. | ThA1 | Invited | Detecting reactive species in hot wire CVD of Si-based films | Stacey Bent<br>Stanford University |
| 9:00 a.m. | ThA2 | Oral | Modeling and Measurement of Film Deposition in a One-Dimensional Hot-Wire CVD System | Colin Wolden<br>Colorado School of Mines |
| 9:20 a.m. | ThA3 | Oral | Effect of Hydrogen Radical on Growth of μc-Si in Hetero-Structured $SiC_x$ Alloy Films | Takashi Itoh<br>Gifu University |
| 9:40 a.m. | ThA4 | Oral | Hot-Wire Chemical Vapor Deposition of High Hydrogen Content Silicon Nitride for Solar Cell Passivation and Anti-Reflection Coating Applications | Jason Holt<br>Caltech |
| ***10:00 to 10:30 a.m.*** | | | ***- Coffee Break -*** | |

**DEVICES – II**

**(10:30 a.m. – 12:00 noon, Thursday)**

**Session Chairman – Brent Nelson (NREL)**

| | | | | |
|---|---|---|---|---|
| 10:30 a.m. | ThB1 | Invited | Thin-Film Transistors Deposited by HWCVD | Bernd Stannowski<br>Utrecht University |
| 11:00 a.m. | ThB2 | Oral | Preparation of Poly-Si Films by Cat CVD for Thin Film Transistor | Hideki Sunayama<br>Anelva Corp. |
| 11:20 a.m. | ThB3 | Oral | Formation of Low-Resistivity Poly-Si and $SiN_x$ Films by Cat CVD for ULSI Application | Rui Morimoto<br>JAIST |
| 11:40 a.m. | ThB4 | Oral | Deposition of Large-Grained Polycrystalline Silicon Films by Hot-Wire CVD for Thin Film Crystalline Solar Cells | Jeong C. Lee<br>Korean Institute of Energy Research |

## THURSDAY AFTERNOON - SEPTEMBER 12

**NEW DEVELOPMENTS – I**
**(1:30 p.m. – 3:40 p.m., Thursday)**
**Session Chairman – Bernd Schroeder (Kaiserslautern University)**

| | | | | |
|---|---|---|---|---|
| 1:30 p.m. | ThC1 | Invited | Application of Decomposed Species Generated by Heated Catalyzer to ULSI Fabrication Process | Akira Izumi<br>JAIST |
| 2:00 p.m. | ThC2 | Oral | Surface Passivation of Crystalline Silicon by Cat-CVD Amorphous and Nanocrystalline Thin Silicon Films | Cristobal Voz<br>Universitat Politecnica de Catalunya (UPC) |
| 2:20 p.m. | ThC3 | Oral | Highly Conductive Microcrystalline Silicon Carbide Films Deposited by Hot-Wire Cell Method and its Application to Amorphous Silicon Solar Cells | Shinsuke Miyajima<br>Tokyo Institute of Technology |
| 2:40 p.m. | ThC4 | Oral | Polymeric CVD Films for Protection of Chemochromic Hydrogen Sensors | J. Roland Pitts<br>NREL/GVD |
| 3:00 p.m. | ThC5 | Oral | Hot Wire Photonics: Materials, Science, and Technology | Charles M. Fortmann<br>State University of New York, Stony Brook |
| 3:20 p.m. | ThC6 | Oral | Epitaxial Growth of Strained SiC Film by Hot Wire Cell Method and its Application to MOS Devices | Tatsuro Watahiki<br>Tokyo Institute of Technology |

## THURSDAY EVENING - SEPTEMBER 12

**POSTER SESSION – food will be provided**
**5:30 – 9:00 p.m.**

| | | | |
|---|---|---|---|
| ThP1 | Poster | Spectroscopic and Kinetic Ellipsometry Studies of Hot-Wire Deposited Polycrystalline Silicon on Glass | Patrick van Veenendaal<br>Utrecht University, Debye Institute |
| ThP2 | Poster | Shutterless deposition of phosphorous doped microcrystalline silicon by Cat-CVD | Marta Fonrodona<br>Universitat de Barcelona |
| ThP4 | Poster | The Influence of the Feedstock Gas on the Filament Temperature in Hot-Wire CVD | Karine van der Werf<br>Utrecht University, Debye Institute |
| ThP5 | Poster | Light Induced Changes of the Crystallinity and Defect Structure of a-Si:H | David Britton<br>University of Cape Town |
| ThP6 | Poster | Strain fields in hydrogenated amorphous silicon | M. Härting<br>University of Cape Town |
| ThP7 | Poster | Preparation of nip Solar Cells entirely by HWCVD with microcrystalline p-Layer | Markus Kupich<br>University of Kaiserslautern |
| ThP8 | Poster | Monte Carlo Simulations on Large-Area Deposition of Amorphous Silicon By Hot-Wire CVD | Bernd Schröder<br>University of Kaiserslautern |
| ThP9 | Poster | Growth process and properties of Hot-Wire CVD deposited silicon nitride | Bernd Stannowski<br>Utrecht University, Debye Institute |
| ThP10 | Poster | Hot-Wire Amorphous Silicon Thin-Film Transistors on PET at 100°C | Joao Conde<br>Instituto Superior Técnico |
| ThP11 | Poster | Substrate influence on the properties of doped thin silicon layers grown by Cat-CVD | David Vilamitjana<br>Universitat de Barcelona |
| ThP12 | Poster | Preparation of B-doped a-Si1-XCX:H films and heterojunction p-i-n solar cells by Cat-CVD method | Kenji Chikusa<br>Gifu University |
| ThP13 | Poster | Switching and Filament Formation in p-Type Hydrogenated Amorphous Silicon Devices | Jian Hu<br>NREL |
| ThP14 | Poster | Key Factors to Improve Efficiency of Cat-CVD a-Si Solar Cells | Masaya Itoh<br>JAIST, |
| ThP15 | Poster | Hydrogen-radical Durability of TiO2 Thin Films for Protecting Transparent Conducting Oxide for Si Thin Film Solar Cells | Hironori Natsuhara<br>Gifu University |

| | | | |
|---|---|---|---|
| ThP16 | Poster | Al2O3 Formation on Si by Cat-CVD | Yoh-Ichiro Ogita<br>Kanagawa Institute of Technology |
| ThP17 | Poster | Coverage properties of silicon nitride film prepared by Cat-CVD method | Shuj Osono<br>ULVAC, Inc. |
| ThP18 | Poster | Fabrication of a-Si1-xCx:H thin films for solar cells by Cat-CVD method using carbon catalyzer | Ken Sugita<br>JAIST |
| ThP19 | Poster | Control of Carrier Concentration in Thin Cuprous Oxide (Cu2O) Films by Catalytically Generated Atomic Hydrogen | Norikazu Tabuchi<br>JAIST |
| ThP20 | Poster | Hot-wire CVD of GaN Films on the Nitrided Layer of GaAs (100) by ECR plasma | Kanji Yasui<br>Nagaoka University of Technology |
| ThP21 | Poster | Epitaxial Growth of c-GaN Films on GaAs (100) Using Hot-wire C | Kanji Yasui<br>Nagaoka University of Technology |
| ThP22 | Poster | Preliminary results on a-Si:C:H based thin film light emitting diode by hot wire CVD | R. Dusane<br>Indian Institute of Technology |
| ThP23 | Poster | Properties of Poly-Si thin films Prepared by plasma assisted HWCVD | Fengzhen Liu<br>Chinese Academy of Sciences |
| ThP24 | Poster | Revisiting the B-factor variation in a-Si:C:H deposited by HWCVD | Bibhu Swain<br>Indian Institute of Technology |
| ThP25 | Poster | Nitrogen dilution effects on structural and electrical properties of hot wire deposited a-SiN:H films for Deep Sub-micron CMOS Technologies | Parag Waghmare<br>Indian Institute of Technology |
| ThP26 | Poster | Small-Angle Neutron Scattering Studies of Hot-Wire CVD a-Si:H | Don Williamson<br>Colorado School of Mines |
| ThP27 | Poster | Influence of heated catalyzer on thermal distribution of substrate in HWCVD system | Meifang Zhu<br>Chinese Academy of Sciences |
| ThP28 | Poster | New dual side Cat-CVD (Hot Wire) low temperature deposition of amorphous and nanocrystalline silicon | Saydulla Persheyev<br>University of Dundee |
| ThP29 | Poster | Hot-Wire Deposition of Amorphous and Microcrystalline Silicon Using Different Gas Excitations By a Coiled Filament | Xunming Deng<br>University of Toledo |
| ThP30 | Poster | Catalytic CVD Growth and Properties of Amorphous Carbon | Hiroshi Nakayama<br>Osaka City University |
| ThP31 | Poster | Bandtail Photolumenesce in Nano-Crystalline Thin Films | Markus Schubert<br>University of Stuttgart |
| ThP32 | Poster | Hot-wire chemical vapor deposition for epitaxial silicon growth on large-grained polycrystalline silicon templates | Maribeth Mason<br>California Institute of Technology |
| ThP33 | Poster | Hydrogen Passivation and Junction Formation on APIVT-Deposited Thin-Layer Silicon by Hot-Wire CVD | Tihu Wang<br>NREL |
| ThP34 | Poster | Stability of ultra-high deposition rate CAT-CVD a-Si:H solar cells | Paul Stradins<br>NREL |
| ThP35 | Poster | Improving Narrow Band Gap a-SiGe:H Alloys Grown by HWCVD | Yueqin Xu<br>NREL |
| ThP36 | Poster | The effect of substrate temperature on HW-CVD deposited a-Si:H films | Sandesh Jadkar<br>University of Pune |
| ThP37 | Poster | Role of Filament Temperature on HW-CVD deposited a-Si:H films | Sandesh Jadkar<br>University of Pune |
| ThP38 | Poster | Influence of Process Pressure on Electrical, Optical and Structural Properties of a-Si:H films deposited by HW-CVD | Sandesh Jadkar<br>University of Pune |
| ThP39 | Poster | Transport Properties of Microcrystalline Silicon Films Deposited by Hot-Wire CVD at Low Temperature | Jean-Eric Bourée<br>Ecole Polytehnique |

## FRIDAY MORNING - SEPTEMBER 13

**FILM PROPERTIES - III**
**(8:30 a.m. – 10:00 a.m., Friday)**
**Session Chairman – Jean-Eric Bouree (Ecole Polytechnique)**

| | | | | |
|---|---|---|---|---|
| 8:30 a.m. | FrA1 | Invited | Fundamental Aspects of Low Temperature Growth of Microcrystalline Silicon | Michio Kondo<br>AIST |
| 9:00 a.m. | FrA2 | Oral | Effect of Dilution Ratio and Seed Layer on the Crystallinity of Microcrystalline Silicon Thin Films Grown by HWCVD | Helio R. Moutinho<br>NREL |
| 9:20 a.m. | FrA3 | Oral | Structural Study on Cat-CVD a-Si:H Films by X-Ray Diffraction and Reverse Monte Carlo Simulation | Norikazu Tabuchi<br>JAIST |
| 9:40 a.m. | FrA4 | Oral | Neutral Dangling Bonds May not be the Dominent Recombination Centers for Photoconductivity in Hot-Wire a-Si:H | Daxing Han<br>University of North Carolina, Chapel Hill |
| ***10:00 to 10:30 a.m.*** | | | ***- Coffee Break-*** | |

**NEW DEVELOPMENTS – II**
**(10:30 a.m. – 12:20 noon, Friday)**
**Session Chairman – Michio Kondo (AIST)**

| | | | | |
|---|---|---|---|---|
| 10:30 a.m. | FrB1 | Invited | Preparation of $SiO_2$ Thin Films using Cat-CVD Method | Kazuya Saitou<br>ULVAC, Inc. |
| 11:00 a.m. | FrB2 | Oral | Hot Wire Chemical Vapor Deposition of Carbon Single-Wall Nanotubes | Anne C. Dillon<br>NREL |
| 11:20 a.m. | FrB3 | Oral | Hot Filament Chemical Vapor Deposition of Polymer Thin Films | Hilton Price Lewis<br>GVD Corp. |
| 11:40 a.m. | FrB4 | Oral | Crystallization by Excimer Laser Annealing for a-Si:H Films with Low Hydrogen Content Prepared by Cat CVD | Yusuke Yogoro<br>JAIST |
| 12:00 noon | FrB5 | Oral | Hot-Wire CVD Growth of Multi-Phase Carbon Nitride Films | Saibal Mitra<br>University of Tulsa |

## FRIDAY AFTERNOON - SEPTEMBER 13

**CLOSING SESSION**
**(13:45 p.m. – 14:30 p.m., Friday)**

| | | | |
|---|---|---|---|
| 13:45 p.m. | Plenary | Summary of conference, demographics | Harv Mahan |
| 13:55 p.m. | Plenary | Summary of conference, science and technology | Joao Conde and Brent Nelson |
| 14:15 p.m. | Plenary | Closing remarks and invitation to 3rd conference | Ruud Schropp |
| 14:30 p.m. | | Conference is officially closed | |